

Drs. Martin and Moule have lately brought out a pamphlet in which full directions are given "how to dissect a Chelonian;" and we are pleased to see from the preface that they intend to follow it by a series of similar works. It is almost a pity that so exceedingly specialised a reptile as a Chelonian should be the first they treat, especially as they intend to include a lizard in the series, for it is doubtless far better to begin the study of reptiles with the latter than with the former.

The species on which the work is based is *Pseudemys rugosa*, but, as Dr. Martin states, "the end in view is not to provide a monograph on any one species, but to show a student 'how to dissect a Chelonian,'" the fact that, when dissecting another species, the description in the book cannot altogether be relied upon, makes the student examine everything carefully for himself.

Without working through the anatomy of a Chelonian with the help of the book it is impossible fully to appreciate its value, but from the arrangement, accuracy, and clearness of description, it will doubtless prove a great boon to the young herpetologist.

The only fault we can find with it is one under which the "Elementary Biology" equally suffers, and that is the want of illustrations. There is a frontispiece with four rather rough woodcuts of the skull (to which no reference letters are given in the text), but this is all.

Of late several illustrated students' biological books, intended as guides for practical work, have been brought out, but most of these are so inaccurate as to be practically useless. It is therefore to be regretted that a book by so eminent a teacher as Dr. Martin should be so poorly provided with figures, and we hope that the rest of the series will be more fully illustrated, as their value would be thereby greatly increased.

Ferns of Kentucky. By John Williamson. (Louisville, Kentucky: J. P. Morton and Co., 1878).

ALTHOUGH this little volume has only just reached us, it cannot be said to be out of date; for the number of popular works on ferns—those published in England excluded—is so small, that an addition to their number is at any time welcome to the fern-lover who has become well acquainted with the common British species, and would gladly increase his knowledge of the tribe. There is, indeed, no parallel in French or German literature to the number of fern-books which have been issued in England; but it would appear from the volume before us that in America fern-hunting is as popular as it is among ourselves; for Mr. Williamson asks in his preface "Who would think now of going to the country to spend a few days, or even one day, without first inquiring whether ferns are to be found in the locality?"

Mr. Williamson has given descriptions of the species found in Kentucky, and the letterpress is accompanied by sixty plates, in which the characters of the genera and the habit of each species is represented. The descriptions, although short and couched in simple language, seem carefully done; and the absence of pretence about the work does not render it the less attractive. Although, of course, primarily intended for local use, the "Ferns of Kentucky" contains much to interest the British lover of ferns.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Hovering of Birds

I AM much obliged to his Grace the Duke of Argyll and to Mr. H. T. Wharton for the notice they have taken of my letter

on the hovering of birds. It may be hoped that the question will not be allowed to rest until it has received its quietus at the hands of some mathematician who shall tell us with authority whether it is possible, according to the received laws of mechanics, for a rigid body, by any disposition of its surfaces, to remain motionless (relative to the earth) for a minute in mid-air in a perfectly horizontal wind.

It is disappointing to find that the 3rd chapter of the "Reign of Law," to which the Duke refers me, contains no satisfactory explanation of the phenomenon of motionless hovering. We read there (p. 161, 5th edition, 1863). "When there is a strong breeze, no flapping is required at all, the force of the wind supplying the whole force necessary to counteract the force of gravity." This is hardly a sufficient explanation. Let us imagine a bird at rest in a horizontal wind. Neglecting friction, the only forces acting on the bird are (1) the vertical force of gravity, and (2) the resultant of the air-pressures on the different surfaces of the bird caused by the horizontal velocity of the wind. These pressures may be resolved parallel and perpendicular to the general plane of the wings, and the direction of their resultant will vary with the slope of the wing-plane; but in every case it will lie to rearward of the vertical, and therefore in every case there will be a resolved horizontal force pushing the bird backwards. Yet in spite of this force the bird is to remain at rest! Shade of Archimedes!

Consider, again, what must be the necessary corollary to the Duke's proposition. If a bird can remain at rest in a horizontal wind, it necessarily follows that in still air a bird can float horizontally without losing velocity. We do indeed see rooks and other birds float long distances descending on outspread wings in still air, and it is marvellous how slow is the descent, so great is the resistance of air to a plane surface when at every successive instant the plane surface covers a fresh body of air that has not yet begun to yield. But no one ever saw a bird maintain a horizontal floating flight in still air. Either the descent is continuous, or the bird loses velocity.

It might be wished, in a matter of such importance, involving as it does nothing less than the establishment of a miracle, that the Duke of Argyll were more precise in his statement, for I feel curious to know by what resolution of forces he would demonstrate the existence of a forward horizontal force to balance the backward force which he cannot deny to be present. A diagram setting forth the Duke's views would be exceedingly welcome. My own diagram, I fear, will not serve his purpose any better than my words, in spite of the attempt he makes to press them into his service. The Duke says: "The bird has only to slope his wing-surfaces to the [horizontal] current, and precisely the same effect is produced as if the current had been otherwise sloped upwards against a horizontal wing-surface." Perfectly true, provided his Grace can tilt the direction of gravity through the same angle. Otherwise not (at the same time there is nothing about a "horizontal wing surface" in my letter).

Mr. Wharton will do good service if, in recording any future observations he will note precisely the local circumstances under which they are made, bearing in mind that such an obstacle as a stack, a barn, a high hedge, or a thick tree might be enough to give the wind an upward throw. I presume he understands that the phenomenon to be explained is that of a bird remaining at rest in mid-air, with wings motionless, not fluttering.

Woodbridge, February 5

HUBERT AIRY

THIS is a very interesting problem, and one which has been very clearly treated by Mr. Hubert Airy, so far as he discusses it.

I think, however, that birds are able to "hover" in other conditions than that he mentions, namely, where the wind is diverted upwards by blowing straight against cliffs or rising ground.

The wind in this country at least is generally of a cyclonic character. Now such wind blows in toward the centre of depression, as has been shown by the Rev. W. Clement Ley, at an average angle of 25 degrees (inward from the tangent to the isobar). If we assume the wind to blow at a distance of 600 miles from such centre at a rate of 20 miles per hour—on an average for one mile in depth—then we have a volume of air converging upon the centre, which must rise into the upper regions there. If we assume, for the sake of obtaining a definite idea of this amount, that the centre of depression covers an area of 70 miles in diameter, say about 4000 square miles, then the air would rise vertically at an average rate of 400 feet per minute over the

area. Owing to the friction which the wind experiences in passing over the surface of the earth, however, this upward current could exist at its maximum only at a considerable height. But it is important to observe that there may frequently be a considerable amount of current upwards in the regions where birds "hover," at least in the neighbourhood of a cyclonic vortex. But how much lifting force is necessary to sustain, say a gull, in the air? A gull moves its wings in ordinary flight at from 160 to 200 (double) strokes per minute, and reckoning 12 inches as the greatest vertical depth through which the bird can raise itself by one (double) stroke, we find that it possesses the power of raising itself about 180 vertical feet per minute. This, however, is less than one-half of the rate at which we have found the currents to rise near the centre of a cyclonic depression. From this we may judge it is likely enough that birds "hover," or suspend themselves motionless in the air through the influence of upgoing currents, which are masked to our observation by the fresh winds which accompany them.

A kestrel may, however, support itself largely by its peculiar quivering play of the wings, and I think it must be difficult to determine how much support a bird may contribute by such motion, when at a height where it is difficult to observe it.

I have frequently observed gulls "hovering" upon currents of air which were heaped up by the wind striking obliquely upon a rising coast line, in which case the head is turned at an angle to the general direction of the wind, so as to face the heaped-up and rising currents. Such passing over irregular ground are irregular or gusty, and tax the bird's utmost muscular agility to prevent a sudden lateral turning to leeward, in which case the rapid flight with the currents may be compared to the fall of a stone to the ground. The same upward direction to the atmospheric currents must be imparted by the contracting sides of a converging valley. But when such local forces derive aid from the upward currents peculiar to cyclonic winds, atmospheric conditions favourable to "hovering" must, I think, frequently occur.

On the other hand, I cannot conceive it to be possible for birds (and I do not think that the third chapter of the "Reign of Law," gives any sufficient explanation) to sustain themselves motionless on currents of air which are purely horizontal, for in such case there is nothing to compensate—when the wings are slanted at the necessary angle to prevent falling—the backward horizontal force, and the creature must inevitably be driven backwards.

DAVID CUNNINGHAM

Dundee, February 5

ON August 12, 1881, I observed a hawk maintaining an apparently stationary position at a height of about 200 feet above the surface of flat ground. He was *as a matter of course* facing the wind, which blew, if I remember rightly, from the west. For the most part his wings remained motionless, but now and then he fluttered them for a little while. This was over the sensibly level plain which lies between Machrihanish Bay and Campbeltown Loch, at the southern end of the Mull of Cantire, and, curiously enough, on or close to the Duke of Argyll's property. The exact spot was about a mile and a half eastwards from Machrihanish Bay, and about three-quarters of a mile northwards from the southern boundary of the plain. There could not be any "slant upward current," such as Mr. Airy supposes, maintaining him in that position; at any rate, there was no sloping ground near.

I watched this bird for about ten minutes, and he verified in a remarkable manner the views I had held on this subject for many years, namely, that, given a steady wind blowing with a velocity which lies somewhere between certain possibly calculable limits, a hawk can remain for a time apparently motionless above a point; he is, in reality, descending a slightly inclined plane, and requires to recover vertically lost ground by the occasional use of his wings.

WILLIAM GALLOWAY

Cardiff, January 30

In the letters on the above subject that have appeared in some recent numbers of NATURE, the writers lead us to believe that a current of air is *necessary* to enable a bird to "hover" or retain when on wing a motionless position. My observations lead to an opposite conclusion, as I have often seen both hawks and terns remain steadily poised, when there was not a breath of wind. That there was no wind where the birds (*terns*) were, was shown by their heads, when hovering, being turned in different directions, although at only a short distance from each other.

Generally, if not always on these occasions, I noticed that the birds spread out their tails in a more or less depressed position, as if to counteract any forward movement likely to be caused by the wing-motion.

J. RAE

4, Addison Gardens, February 3

IN reading the letters published in your last issues of NATURE with regard to the hovering of birds, it struck me that a very similar thing can be seen sometimes, among inanimate objects when an imperfect attempt is made to cause "ducks and drakes" with a flat stone. I have commonly noticed that the missile curves sharply upwards and for a moment "hovers" as it were, in mid-air before dropping. In this case and also in the similar one of the motion of the boomerang, the slanting upwards and the apparent hovering do not require, and need not be due to, upward currents, but merely depend upon the force of a horizontal current of air meeting the inherent force of the moving body. It is not unreasonable to suppose a similar simple solution of bird hovering.

C. S. MIDDLEMISS

Linnaeus Street, Hull, February 3

Is there not an error in the letter of NATURE (p. 312)? The writer there suggests, as it seems to me, that a bird could maintain a position of rest, with respect to the earth, by a suitable slope of the wings against a horizontal wind. Now, as I pointed out in NATURE, vol. xxiii. p. 78, such lifting action on the part of the wind can only take place in the interval between the time when the bird is first launched from the cliff, and the time when it has by friction attained the velocity of the wind. That this interval is not a long one, is shown when balloons or other objects are launched.

[It may be well to notice, that if there were *no* friction there is no lifting power; so that if we object to the above, that "the bird gives such a *very* small friction with the wind," we thereby do away to the same extent with the lifting power; just as a frictionless ship in a constant stream would be unmoved were it sufficiently tapering.]

From the above considerations I have been compelled, since writing my last letter, to ascribe the hovering power of birds—

1. To the "exquisite muscular sense" by which they can take advantage of all upward currents of air, shifting their positions for this purpose. In an elastic fluid as the air, I imagine that the stream-lines, even over the sea, are far from horizontal. I believe the evidence of balloons over the sea goes to show this.

2. There is, to use a common expression, "flying *and* flying," just as a man can skate without striking out, so can a bird give itself some support by quiet movements of wings and tail.

I may remark that kestrels keep fluttering their wings at short intervals while hovering; they are never still for long. So also terns and gulls, as seen from the fixed point of a cliff, are always moving and shifting in a quiet way, which may disguise both a seeking of upward currents and the quiet sort of "flying."

W. LARDEN

Cheltenham College

Science and Theology

CAN you tell me by what right the authorities of Cooper's Hill Engineering College, who are in want of a Professor of Physics, make it a condition that he should "be a Protestant," and should "attend morning chapel and Sunday services with reasonable regularity, showing in this respect a good example to the students?" The institution is one supported by the State, and is surely bound to respect the principles which underlie the State's dealings with religious matters. The president (or whoever is responsible for these preposterous conditions) may have forgotten this fact; but I cannot believe that the present Government will allow an appointment to be made until all "religious" limitations are cancelled from its conditions. As the memorandum stands at present, it appears little short of insulting to scientific men.

C.

Intelligence in Animals

MR. GRENFELL's letter in NATURE, vol. xxvii. p. 292, reminded me of a statement in vol. iii. p. 308 of Cook's last voyage, where Capt. King refers to the ordinary sagacity of bears, described in a "thousand stories" which he heard in